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ORIGINAL ARTICLE

Early Postoperative Outcome after Evacuation of Acute Subdural Haematoma – A Comparison of Craniotomy with Decompressive Craniectomy

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Mohammad Jainul Abadin[1], Atiqure Rahman Rimel[2], Sumaiyya Rumman[3], Rezina Afrin[4], Sirazul Haque Ershad[5]

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Correspondence to
Atiqure Rahman Rimel

ORCID
https://orcid.org/0009-0007-0612-1996

ABSTRACT
Background: *Acute subdural hematoma represents a major clinical entity in traumatic brain injury. The mortality of traumatic acute subdural haematoma is high. Craniotomy and decompressive craniectomy are two commonly used surgical techniques for treatment of traumatic acute subdural hematoma but which one is better surgical technique is still under debate.* ***Objective:*** *This study was done to evaluate the surgical outcome of traumatic acute subdural hematoma and to compare the surgical outcome between craniotomy and decompressive craniectomy with evacuation of hematoma.* ***Methods & Materials:*** *A hospital based randomized clinical trial was conducted from July 2016 to December 2017. Total 36 patients with traumatic acute subdural hematoma with pre-operative GCS 5-13, thickness of hematoma more than 10 mm, midline shift more than 5 mm and at least one pupil was reacting to light were included in this study. Data were collected by specially designed case record form and analysed usingStatisticalPackage for Social Sciences (SPSS) version 22.0).* ***Results:*** *Regardless of surgical technique used that is craniotomy (CR) or decompressive craniectomy (DC) with evacuation of hematoma, good recovery (GOS score-5) was 33.3%, moderate disability (GOS score= 4) 19.4%, severe disability (GOS score-3) 5.6%, persistent vegetative state (GOS score-2) 5.6%, and 36.1% patient died after surgery. In CR group according to Glasgow outcome scale (GOS) good recovery was 33.3%, moderate disability 11.1%, severe disability 11.1%, persistent vegetative state 5.6% and 38.9% patients died. In DC group, good recovery was 33.3%, moderate disability 27.8%, severe disability 0%, persistent vegetative state 5.6% and 33.3% patients died.* ***Conclusion:*** *Patients with traumatic acute subdural hematoma with GCS ≥ 9, bilateral reacting pupil and surgery within 24 hours craniotomy (CR) may be an alternative surgical option considering the possible complications of decompressive craniectomy as craniotomy and decompressive craniectomy showed no difference. But patients with poor clinical status and surgery after 24 hours primary decompressive craniectomoy (DC) may be more effective than craniotomy.*

Keywords: *Acute subdural haematoma; Traumatic brain injury; Craniotomy; Decompressive craniectomy; Surgical outcome; Glasgow Outcome Scale; Postoperative mortality; Randomized clinical trial.*

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1. *Assistant Professor, Department of Neurosurgery, Central Medical College & Hospital, Cumilla, Bangladesh.*
2. *Neurosurgeon, Department of Neurosurgery, National Institute of Neurosciences & Hospital, Dhaka, Bangladesh*
3. *Registrar, Department of Gastroenterology, National Gastroliver Institute and Hospital, Dhaka, Bangladesh*
4. *Medical Officer, Department of Gynecological Oncology, National Institute of Cancer Research and Hospital, Dhaka, Bangladesh*
5. *Associate Consultant, Department of Neurosurgery, Square Hospital Limited, Panthapath, Dhaka, Bangladesh*

INTRODUCTION

Acute subdural haematoma (ASDH) is one of the most life-threatening neurosurgical emergencies and a critical component of the global burden of traumatic brain injury (TBI). It occurs in approximately one-third of patients with severe TBI and is strongly associated with poor neurological outcomes and high mortality[1]. ASDH typically develops between the dura mater and the arachnoid membrane due to tearing of bridging veins or arterial injury following rapid acceleration–deceleration forces or direct head trauma [2]. The condition progresses rapidly, causing mass effect, midline shift, raised intracranial pressure (ICP), and impaired cerebral perfusion, all of which contribute to secondary brain injury [3]. Despite improvements in neuroimaging, neurocritical care, and surgical techniques, mortality in severe ASDH remains exceedingly high, frequently exceeding 50–60%, and is closely related to the initial Glasgow Coma Scale (GCS) score and the presence of concomitant parenchymal injuries [4,5]. The clinical outcome in ASDH depends not only on the size of the clot but also on the extent of the underlying primary brain damage, including cerebral contusions, diffuse axonal injury, and traumatic brain oedema [6]. These secondary brain insults play a decisive role in long-term functional recovery. Timely surgical intervention is essential when there is significant mass effect or neurological deterioration, as early evacuation reduces intracranial pressure, prevents herniation, and facilitates better cerebral perfusion [7]. Among the surgical interventions available, craniotomy (CR) and decompressive craniectomy (DC) are the two most widely practiced techniques for evacuating ASDH. Craniotomy allows clot evacuation followed by bone flap replacement, whereas decompressive craniectomy involves removal of the bone flap to accommodate brain swelling and reduce ICP. Although both procedures are well established, their relative benefits remain controversial. Some studies suggest craniotomy is adequate for most patients with minimal swelling, while others report improved ICP control with decompressive craniectomy, particularly in cases with significant brain oedema or refractory intracranial hypertension[8]. Despite extensive research, there is still no definite consensus regarding the optimal surgical approach for primary ASDH evacuation, and decisions often depend on surgeon preference and intraoperative findings [9,10]. Because of these uncertainties, further comparative evaluation of postoperative outcomes is essential. Therefore, the present study aims to compare the early postoperative outcomes of craniotomy versus decompressive craniectomy in the surgical management of acute subdural haematoma, with the objective of identifying the approach that offers better early recovery and clinical stability in patients with traumatic acute subdural haematoma (ASDH).

METHODS & MATERIALS

This randomized clinical trial was conducted in the Department of Neurosurgery, Dhaka Medical College Hospital, from July 2016 to December 2017. Written informed consent was obtained from the caregivers/legal guardians and initially 40 patients diagnosed with acute subdural haematoma requiring surgical evacuation were enrolled in this study. During surgery, six patients (four initially allocated to the craniotomy group and two to the decompressive craniectomy group) developed significant per-operative brain swelling, necessitating conversion to decompressive craniectomy. These patients were subsequently excluded from the study and to maintain group balance, two additional patients were further recruited into the craniotomy group and finally a total of 36 patients were included and categorized into two groups based on the surgical procedure performed: craniotomy (CR) group comprised 18 patients and decompressive craniectomy (DC) group comprised 18 patients. At admission Glasgow Coma Scale (GCS) was used to measure the depth and duration of impaired consciousness and coma of the cases. After 1 month follow up, the postoperative functional outcomes were measured by Glasgow Outcome Scale (GOS) and good outcome was determined by GOS score 5 and 4 and poor outcome was determined by GOS score 3,2 and 1. A pre-structured case record form was used to collect the data of this study. The collected data were methodically organized and analyzed using Statistical Package for Social Sciences (SPSS), version-22.0. Descriptive statistical analysis were performed and the results were presented as frequency and mean in the tables Chi-square test, Fisher's Exact test and unpaired t test were performed to compare the baseline, clinical and outcomes variables of the study, where, p<0.05 considered as the level of significance. The ethical clearance of this study was obtained from the Institutional Review Board (IRB) of Dhaka Medical College Hospital, Dhaka, Bangladesh.

RESULTS

A total of 36 patients were included in this study, with 18 in the craniotomy (CR) group and 18 in the decompressive craniectomy (DC) group. In the CR group, the most frequent 8 (44.4%) patients were aged 21–40 years and followed by 4 (22.2%) were 41–60 years, and 6 (33.3%) were 61–80 years. In the DC group, the most frequent 7 (38.9%) patients were aged 21–40 years and followed by 3 (16.7%) patients were aged 11–20 years and the same 3 (16.7%) were 41–60 years, and 5 (27.7%) were 61–80 years. The mean age of the patients of CR group was (50.36 ± 20.88 years) and the DC group was (41.77 ± 20.52 years) (p=0.164). In the CR group, 15 (83.3%) were male and 3 (16.7%) were female, whereas in the DC group, 12 (66.7%) were male and 6 (33.3%) were female. (p = 0.443) (Table-I). Road traffic accidents (RTA) were the most common cause, accounting for 22 (61.1%) of the cases. Among these, 9 (50.0%) occurred in the CR group and 13 (72.2%) in the DC group. Falls from height were responsible for 6 (16.7%) injuries, equally distributed between the groups: 3 (16.7%) in CR and 3 (16.7%) in DC. Fall of heavy weight accounted for 2 (5.6%) cases, with 1 (5.6%) from each group. Physical assault was observed in 6 (16.7%) cases, including 5 (27.8%) in the CR group and 1 (5.6%) in the DC group. (p = 0.295) (Table-II). In the CR group, 10 (55.6%) cases had right-sided haematoma and 8 (44.4%) had left-sided involvement. Likewise, in the DC group, 11 (61.1%) haematomas were right-sided and 7 (38.9%) were left-sided. (p = 0.502).. The mean midline shift was measured 8.38 ± 2.47 mm in the CR group and 8.41 ± 2.37 mm in the DC group (p = 0.782). Similarly, the mean thickness of the haematoma showed no meaningful difference, measuring 13.67 ± 3.16 mm in the CR group and 13.33 ± 2.65 mm in the DC group (p = 0.743) (Table-III). At admission in the CR group, 1 (5.6%) patient presented with a GCS score of 5–6, 5 (27.8%) with a score of 7–8, 9 (50.0%) with a score of 9–10, and 3 (16.7%) with a score of 11–13. In the DC group, 1 (5.6%) patient had a GCS of 5–6, 9 (50.0%) presented with a score of 7–8, 3 (16.7%) had a score of 9–10, and 5 (27.8%) had a score of 11–13 (p = 0.20) (Table-IV). The mean time interval between the incident and the operation was 24.27 ± 10.73 hours in the CR group and 21.72 ± 6.78 hours in the DC group (p= 0.399). Similarly, the time interval between hospital admission and the operation was comparable between groups, measuring 5.36 ± 3.20 hours in the CR group and 6.15 ± 2.68 hours in the DC group (p = 0.611). Patients undergoing craniotomy stayed in hospital 13.54 ± 4.48 days, whereas those in the DC group stayed 5.50 ± 6.64 days (p= 0.422) (Table-V). According to the Glasgow Outcome Score (GOS) at 1-month follow-up, in the CR group, 7 (38.9%) patients had died, 1 (5.6%) remained in a persistent vegetative state, 2 (11.1%) experienced severe disability, 2 (11.1%) showed moderate disability, and 6 (33.3%) achieved good recovery. In the DC group, 6 (33.3%) patients had died, 1 (5.6%) remained in a persistent vegetative state, none showed severe disability, 5 (27.7%) achieved moderate disability, and 6 (33.3%) achieved good recovery. Which was not statistically significant (p= 0.565) (Table-VI). In the craniotomy group, functional outcomes varied according to age and clinical characteristics. Among patients aged <40 years, 5 (71.4%) achieved a good outcome, while 2 (28.5%) experienced a poor outcome. In contrast, among those aged ≥40 years, only 3 (27.3%) had a good outcome whereas 8 (72.7%) had a poor outcome. (p = 0.145). GCS at admission also influenced outcomes, with 1 (16.7%) good and 5 (83.3%) poor outcomes among patients with GCS ≤8, compared to 7 (58.3%) good and 5 (41.7%) poor outcomes among those with GCS >8 (p= 0.152). Patients operated within 24 hours showed markedly better outcomes, with 8 (72.7%) achieving good outcome and 3 (27.3%) showing poor outcome. Conversely, all patients operated after 24 hours had poor outcomes (0% good vs. 7 (100%) poor), and this relationship was statistically significant (p = 0.004). Pupillary response did not show a significant association. Among those with normal or

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reactive pupils, 6 (50.0%) had good outcomes and 6 (50.0%) had poor outcomes. For those with unilateral fixed dilated pupils, 2 (33.3%) had good and 4 (66.7%) had poor outcomes (p=1.000). In the decompressive craniectomy group, 7 (70.0%) of patients aged <40 years had good outcomes compared to 3 (30.0%) with poor outcomes, whereas among those aged ≥40 years, 3 (37.5%) achieved good outcomes and 5 (62.5%) had poor outcomes which was not statistically significant (p = 0.342). For patients with GCS ≤8, 4 (40.0%) experienced good and 6 (60.0%) poor outcomes; among those with GCS >8, 6 (75.0%) had good and 2 (25.0%) had poor outcomes which was not significant (p = 0.188). Time to surgery showed that patients operated within 24 hours had better outcomes (9 (69.2%) good vs. 4 (30.8%) poor) compared to those operated after 24 hours (1 (20.0%) good vs. 4 (80.0%) poor) which was not statistical significance (p = 0.188). Pupillary response similarly did not show a significant association. Among patients with normal or reactive pupils, 8 (57.1%) achieved good outcomes and 6 (42.9%) had poor outcomes. In those with unilateral fixed dilated pupils, outcomes were evenly distributed, with 2 (50.0%) good and 2 (50.0%) poor (p=0.559) (Table-VII). The overall functional outcomes at 1 month demonstrated that 8 (44.4%) patients in the CR group achieved a good outcome, while 10 (55.6%) had a poor outcome. In comparison, 11 (61.1%) patients in the DC group experienced a good outcome, and 7 (38.9%) had a poor outcome. Although good outcomes were more frequent in the DC group, the difference between the two groups was not statistically significant (p = 0.317) (Table-VIII).

Table – I: Age and sex distribution of the study subjects (*n*=36)

	Group		p value
	CR(n=18)	DC(n=18)	
	n (%)	n (%)	
Age (years)			
11--20	0(0.0)	3 (16.7)	0.504
21 – 40	8 (44.4)	7 (38.9)	
41 – 60	4 (22.2)	3 (16.7)	
61 – 80	6 (33.3)	5 (27.7)	
Mean ±SD	50.36 ± 20.88	41.77 ± 20.52	0.164
Min - max	21 – 80.00	17 – 72.00	
Sex			
Male	15(83.3)	12(66.7)	0.443
Female	3(16.7)	6(33.3)	

Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

Table – II: Mode of injury of the study subjects (*n*=36)

Mode of injury	Group		Total	p value
	CR(n=18)	DC(n=18)		
	n (%)	n (%)		
RTA	9(50.0)	13 (72.2)	22(61.1)	0.295
Fall from height	3 (16.7)	3 (16.7)	6 (16.7)	
Fall of heavy weight	1 (5.6)	1 (5.6)	2 (5.6)	
Physical assault	5 (27.8)	1 (5.6)	6 (16.7)	

Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

Table – III: Location and thickness of haematoma and midline shifting of the study subject (*n*=36)

	CR(n=18)	DC(n=18)	p value
	n (%)	n (%)	
Acute sub dural haematoma			
Right	10 (55.6)	11 (61.1)	0.502
Left	8 (44.4)	7 (38.9)	
Midline shifting (mm)	8.38 ± 2.47	8.41 ± 2.37	0.782
Thickness of Hematoma (mm)	13.67 ± 3.16	13.33 ± 2.65	0.743

Unpaired t test and Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

Table – IV: At admission GCS score of the study subjects (*n*=36)

GCS score	Group		p value
	CR(n=18) n (%)	DC(n=18) n(%)	
5-6	1 (5.6)	1 (5.6)	0.212
7-8	5 (27.8)	9 (50.0)	
9-10	9 (50.0)	3 (16.7)	
11-13	3 (16.7)	5 (27.8)	

Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

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Table – V: Time interval between incidence & operation and length of hospital stay (*n*=36)

Time interval and length of hospital stay	Group		p value
	CR(n=18)	DC(n=18)	
Time interval between incidence and operation (hours)	24.27 ± 10.73	21.72 ± 6.78	0.399
Time interval between admission and operation	5.36± 3.20	6.15 ± 2.68	0.611
Length of hospital stay (days)	13.54± 4.48	15.5± 6.64	0.422

Unpaired t tests were performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

Table – VI: Distribution of functional outcome of the study patients according to GOS Score after 1 month follow up (*n*=36)

Functional Outcome	Group			p value
	CR(n=18) n (%)	DC(n=18) n (%)	Total	
Dead	7(38.9)	6(33.3)	13(36.1)	0.565
Persistent vegetative state	1(5.6)	1(5.6)	2(5.6)	
Severe disability (conscious but disabled)	2(11.1)	0(0.0)	2(5.6)	
Moderate disability (disabled but independent)	2(11.1)	5(27.7)	7(19.4)	
Good Recovery	6(33.3)	6(33.3)	12(33.3)	

Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI.

Table – VII: Distribution of functional outcome of the study patients by age and clinical determinants after 1 month follow up (*n*=36)

CR Group(n=18)		Outcome		p value
		Good outcome	Poor outcome	
Age(years)		n (%)	n (%)	0.399
	<40	5(71.4)	2(28.5)	0.145
	≥40	3(27.3)	8(72.7)	
GCS				
	≤ 8	1(16.7)	5(83.3)	0.152
	>8	7(58.3)	5(41.7)	
Time interval and operation (hours)				
	≤ 24	8(72.7)	3(27.3)	0.004
	>24	0(0.0)	7(100)	
Pupil				
Normal or dilated but reacting		6(50.0)	6(50.0)	1.000
Dilated and fixed (Unilateral)		2(33.3)	4(66.7)	
DC Group(n=18)				
Age(years)				
	<40	7(70.0)	3(30.0)	0.342
	≥40	3(37.5)	5(62.5)	
GCS				
	≤ 8	4(40.0)	6(60.0)	0.188
	>8	6(75.0)	2(25.0)	
Time interval and operation (hours)				
	≤ 24	9(69.2)	4(30.8)	0.188
	>24	1(20.0)	4(80.0)	
Pupil				
Normal or dilated but reacting		8(57.1)	6(42.9)	0.559
Dilated and fixed(Unilateral)		2(50.0)	2(50.0)	

Fisher's exact tests were performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI. Good outcome= Glasgow outcome scale score 5 and 4. Poor outcome= Glasgow outcome scale score 3, 2 and 1.

Table – VIII: Distribution of total good vs poor outcome of the study patients after 1 month follow up (*n*=36)

Outcome	Group		p value
	CR(n=18) n(%)	DC(n=18) n(%)	
Good outcome	8(44,4)	11(61.1)	0.317
Poor outcome	10(55.6)	7(38.9)	

Chi-square test was performed to measure the level of significance, p<0.05 considered as the level of significance with 95% CI. Good outcome= Glasgow outcome scale score 5 and 4. Poor outcome= Glasgow outcome scale score 3,2 and 1.

DISCUSSION

Traumatic acute subdural haematoma (ASDH) remains one of the most lethal types of head injury, in which primary brain injury appears to be a more decisive prognostic factor than the haematoma itself [11]. Despite major advances in emergency medical care, neuroimaging, surgical techniques and intensive care support, the morbidity and mortality associated with ASDH continue to be substantially high across treatment centres worldwide [12]. A recent study demonstrated that outcomes in severe head injury depend more on initial clinical condition, the extent of intracranial damage, associated injuries, patient age, and the timing of surgical intervention rather than the characteristics of the haematoma alone[13]. In contemporary neurosurgical practice, craniotomy (CR) and decompressive craniectomy(DC) remain the two principal operative techniques performed for ASDH

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evacuation. The present study demonstrated that age, pre-operative GCS, pupillary response, and time interval between injury and surgery significantly influence postoperative outcomes. Moribund patients with GCS 3–4 and bilateral fixed pupils were excluded, along with six additional cases with peroperative severe brain swelling. The highest proportion of patients in this study belonged to the 21–40-year age group, which is consistent with prior study reporting a similar age distribution among ASDH patients [14], and the mean age values in this series closely resemble those reported in comparable cohorts [15]. Younger patients demonstrated better outcomes, while older age was strongly associated with poor prognosis, a trend well established in previous literature showing mortality exceeding 70% among patients older than 40 years [16]. Male predominance was observed in this cohort, a pattern that aligns with multiple reports of higher incidence of traumatic ASDH among young males due to greater exposure to high-risk activities [14]. However, the present study found no significant prognostic difference between the two sexes, which is consistent with findings from other research demonstrating no major outcome variation attributable to sex [17]. Road traffic accidents (RTAs) constituted the leading cause of ASDH in this study, followed by falls and physical assault, which mirrors the dominant injury patterns described in a similar study conducted in developing regions [18]. Preoperative neurological status emerged as a key determinant of outcome. Among patients with GCS ≤8, those treated with DC demonstrated better favourable outcomes than those undergoing craniotomy. This finding parallels observations from a study involving 91 patients, in which DC yielded superior results in severely impaired individuals [19]. Patients presenting with moderate GCS (9–13) showed improved outcomes with both procedures, though DC demonstrated a slightly higher proportion of favourable recovery. Timing of surgery also played a crucial role, as patients operated within 24 hours had substantially better recovery compared with those treated after 24 hours. This finding supports previous evidence suggesting that shorter intervals between injury and surgical intervention are associated with more favourable neurological outcomes [20]. Pupillary light reflex was another important prognostic factor. Patients with bilateral reacting pupils had markedly better outcomes compared with those with unilateral fixed dilated pupils. This relationship is consistent with earlier reports emphasizing the high mortality associated with absent or abnormal pupillary reflexes in ASDH patients [21]. The overall mortality in this study was 36.1%, slightly higher in the craniotomy group, which is within the range of previously reported mortality rates [22]. Overall, the favourable outcome rate in this study was 52.78%, with no statistically significant difference between craniotomy and decompressive craniectomy. However, subgroup analyses suggest that DC may be more beneficial in patients presenting with low GCS scores, unilateral fixed pupils, or delayed presentation, although these trends did not reach statistical significance [23]. Finally, the results of this study reaffirm that surgical outcomes in ASDH are primarily determined by three major factors, preoperative GCS, pupillary response and timing of surgery. Patients presenting with GCS above 8, bilateral reacting pupils, and early surgical intervention (within 24 hours) demonstrated favourable outcomes irrespective of surgical technique. While DC tended to offer better outcomes in patients with severe neurological deficits or late presentation, hence, a longitudinal study would be required to establish definitive conclusions regarding the superiority of one technique over the other.

LIMITATIONS OF THIE STUDY

This study is limited by its small sample size and single-center design, which may not represent a large population Postoperative long-term functional outcome follow up were not assessed due to the time constraint of the study. Finally, due to financial constraint radiological factors were also not evaluated in this study.

CONCLUSION

Patients with traumatic acute subdural hematoma with GCS ≥ 9, bilateral reacting pupil and surgery within 24 hours craniotomy (CR) may be an alternative surgical option considering the possible complications of decompressive craniectomy as craniotomy and decompressive craniectomy showed no difference. But patients with poor clinical status and surgery after 24 hours primary decompressive craniectomoy (DC) may be more effective than craniotomy.

RECOMMENDATIONS OF THE STUDY

Future studies with larger, multicentre samples are recommended to validate the comparative effectiveness of craniotomy and decompressive craniectomy in acute subdural hematoma. Long-term follow-up should be incorporated to assess functional recovery beyond the early postoperative period. Inclusion of detailed radiological parameters may also help refine surgical decision-making.

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